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Erythrism in the Eastern Grass Snake, *Natrix natrix* (Linnaeus, 1758)

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Abstract

We describe the unusual case of erythrism in the Eastern Grass Snake, *Natrix natrix*. This colour morph is very rare and has not been reported in the literature before. Despite having observed thousands of *N. natrix* in the field, we personally detected this morph in only three individuals originating from Slovakia, Romania, and mainland Greece, while photos of a fourth individual from a Greek island were provided to us. In addition, a recent study with a large data set from citizen scientists was unable to produce a single reddish Eastern Grass Snake. Such colouration is likewise uncommon in the western members of Grass Snakes (*N. helvetica*, *N. astreptophora*), with two examples provided herein. Because the potential biological importance of erythristic colouration is unclear, we encourage other field herpetologists and naturalists to publish their observations of reddish Grass Snakes in the printed literature.

Key Words

colour morph, Colubridae, Natricidae, phenotype, rare observation

Grass Snakes (*Natrix natrix* sensu lato) are among the best studied snake species in the Western Palaearctic (Kabisch 1999; Kindler et al. 2017). Before the era of molecular taxonomy, up to 14 morphologically defined subspecies were recognised under the taxon with some of them representing island endemics (e.g., *N. n. schweizeri* Müller, 1932). Recently, the biogeography, evolution and taxonomy of Grass Snakes has been widely investigated (e.g., Kindler et al. 2013, 2017; Pokrant et al. 2016; Schultze et al. 2020), showing significant discrepancies and conflicts between taxonomy and genetic data (Fritz and Schmidtler 2020). It resulted in two species distributed in Western Europe [*N. astreptophora* (Seoane, 1884), *N. helvetica* (Lacepède, 1789)] and *N. natrix* (Linnaeus, 1758) sensu stricto, occupying a vast area east of a line between Scandinavia and the Alps as far as the Baikal Lake in Russia. Several morphologically defined taxa have been synonymised and some colour morphs were recognised as a result of phenotypic plasticity without any taxonomical justification. A typical example is *N. natrix persa* (Pallas, 1814), a morphotype with often two light dorsal stripes along the body. This morphotype has been, however, found in several, different evolutionary lineages (Kindler et al. 2013, 2017) and thus it becomes a junior synonym of *N. n. scutata* (Pallas, 1771) (Asztalos et al. 2021). The current taxonomy of *N. natrix* sensu stricto now includes four subspecies (Asztalos et al. 2021) with a high level of phenotypic variability. Furthermore, the Grass Snakes also display different colour forms and aberrations, including albinism or melanism (Jandzík 2004; Papezikova et al. 2020). However, no published reports so far exist of erythrism in *N. natrix*.

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Erythrism is usually defined as an unusually increased amount of red pigmentation on an animal's body surface. However, the assessment of a colouration red and reddish certainly underlies some subjective variation. First, there is great individual variation in the quantity of red-sensing colour-receptors (cones) in the retina, even though such differences are largely compensated in the brain (Hofer et al. 2005; Bosten 2022); second, there are individual differences in the resolving power, respectively visual acuity, to perceive small patches or spots of red skin (Perkins and Davson 2021); third, perception of red can depend on the ecdysis stage (shedding stage), respectively the amount of visual obstruction by old skin covering the epidermal pigments; fourth, erythrism can vary by different shades of red, such as reddish-brown (a mixing of red with blue or black pigments) or orange (mixing of red with yellow pigment). We, therefore, applied an empirical but mutually concordant assessment to label those specimens as erythristic that we perceive as expressing an unusual amount of red (red pigments) or reddishness (shades of red) in the skin colouration outside the reddish lunar spot. Hence, a provisional assessment is based on our observations, including many close inspections, and photographs, of more than 1000 Grass Snakes among us. We thus checked the RGB (Red Green Blue) colour profile of photographs from all below described erythristic individuals using CorelDRAW Graphics Suite software which provides a useful standard for what colour is present on photographs of the snake's body.

On 2 August 2021, the first author captured an unusually reddish (erythristic), subadult individual of *Natrix natrix vulgaris* Laurenti, 1768 in an artificial canal of the Hron River in Kamenica nad Hronom, Slovakia (47.819°N, 18.736°E, 107 m a. s. l.). This individual measured only around 30 cm in total length; however, its bright reddish colouration rendered it highly visible from dozens of meters while swimming in the water.

Figure 1. The erythristic individual of *Natrix natrix* from Slovakia in different body views: **A.** Ventral part; **B.** Dorsal part; **C.** Lateral scalation; **D–G.** Details on the head coloration. Photographs by Daniel Jablonski.

Figure 2. Reddish individuals of Eastern Grass Snakes: **A.** Reddish *Natrix natrix* from the Danube Delta, Romania; photograph by Benny Trapp; **B.** Reddish *N. natrix* from Nestani, Peloponnese, Greece; photograph by Elias Tzoras; **C.** The reddish individual from Samos Island, Greece; photograph by Ivo Peranić.

Figure 3. Reddish individuals of other species of Grass Snakes: **A.** Reddish Western Grass Snake (*Natrix helvetica*) from Cistude Nature, Le Haut Perché, Bordeaux, France (44.893°N, 0.679°W), 21 October 2013, photograph by Matthieu Berroneau; **B.** Reddish Iberian Grass Snake (*Natrix astreptophora*) from Verdes (43.219°N, 8.771°W), Coristanco, A Coruña, Spain, 10 July 2009, photograph by Pedro Galán.

The reddish colouration was visible along the whole body (Fig. 1A, B) with striking reddish pigment present on the dorsum as well as the light part of the venter (Fig. 1B, C). The head also exhibited a gradient from dark orange to red, beginning at the rostrum, and spreading across the supralabials, the pre- and postoculars to the crescents or lunar spots (Fig. 1D–F). The ventral part of the head was also reddish with a whitish centre (Fig. 1G). The individual had a reddish tinge on all scales, which are usually very dark to black (see darker parts of ventral scales and colouration after crescents). For this individual we generally recorded the following RGB values (Hex triplet): head part (#fe9900 and #fead30), darker pigment around eyes (#dc6205), ventral scales (#d78754), and dorsal scales on lateral side of the body (#cd711E) representing mainly red colour.

On 15 April 2013 Benny Trapp photographed a reddish *N. natrix* of 50–60 cm total length at Sfântu Gheorghe in the Danube Delta, Romania (44.894°N, 29.609°E, approximately 1 m a. s. l.), an extensive marshland with reed vegetation and sandy soil near the Black Sea. Its subspecies status cannot be specified due to the possible contact of several lineages in that area (Asztalos et al. 2021). This individual was a male of the striped "persa" morph with small dark spots on the dorsum, but otherwise appeared very similar to the individual from Slovakia (Fig. 2A). Its reddish colouration was also predominant from the lower part of the rostrum (#d27534), all labials (#ee9937), crescents (#eb6200) and all light patches on the venter were bright orange instead of white, and the usual greyish dorsal scales revealed a reddish tinge with the lower lateral spots (#ef870a) exhibiting a striking orange border.

A third reddish striped "persa" male *N. natrix moreotica* (Bedriaga, 1882) was photographed by Elias Tzoras on 24 March 2019 in a marshland surrounded by mountains near Nestani, Peloponnese, Greece (37.622°N, 22.460°E, approximately 620 m a. s. l.). It was approximately 30 cm in total length and showed reddish colourations on rostrum (#a25624), labials (#dd8022), crescents (#df7937) and posterior to the light part of the venter but was generally darker with larger lateral and medium dorsal blotches bordered by orange compared to the previous two individuals (Fig. 2B).

To the best of our knowledge, no previous publication describes such colouration in *N. natrix*. Moreover, after many hundreds of personally observed individuals of *N. natrix* in the field, these three individuals were the only ones detected by us. Also, according to personal communication with Uwe Fritz (December 2021), he himself has never recorded a similar phenotype in the field or while investigating colour variability of more than 5,700 Grass Snakes based on citizen science data (Fritz and Ihlow 2022). However, an online search revealed one additional erythristic individual, a *N. natrix* from Ireo, Samos Island, Greece (37.677°N, 26.873°E, 28 August 2019) posted by Ivo Peranić who subsequently provided detailed information to us (Fig. 2C). This individual of about 70 cm total length was found in a dry riverbed and characterized by reddish colouration of the body, resembling the other reddish Eastern Grass Snake from Greece.

Rare observations of erythristic individuals have been made in the other two Grass Snake species, *N. helvetica* Lacépède, 1789 and *N. astreptophora* (Seoane, 1885), formerly subspecies of *N. natrix*. For each species, we provide here an example, one from France and one from Spain (Fig. 3). Nonetheless, photographer Matthieu Berroneau confirmed that such reddish Western or Barred Grass Snakes (*N. helvetica*) can be observed occasionally, yet regularly, in the region around Bordeaux, France, particularly in water bodies high on tannic acid that colourises the water dark reddish, and thus, possibly exhibiting a cryptic effect for such Grass Snakes. All records of reddish Eastern Grass Snakes herein originate from flat areas, such as depressions/marshlands between hills with or without patches of forests between 0–100 m a. s. l., except for the Peloponnese, Greek, individual that inhabited a depression around 600 m a. s. l.

Yet, it remains, that we can only speculate about the biological significance that is behind such reddish phenotypes and their rare manifestations in wild snake popula-

tions (cf. Mačát et al. 2016; Zúñiga-Baos 2020; Borteiro et al. 2021). Thus, due to the rarity of this colour morph in Grass Snakes, we would like to encourage more field herpetologists and naturalists to present their unusual observations of Grass Snakes with reddish colouration. Providing more records from the field with proper information about the geographic origin, type of the habitat, age and other valuable information may help to better understand this spectacular colour variation.

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